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13. ABSTRACT *(Maximum 200 words)*

Elastic protein-based polymers have been synthesized. These are solid materials having been cross-linked by gamma-ray irradiation. Three (3) of these samples have been measured. The results show that their elastic properties are different from traditional rubbers and polyurethanes. Typical absorbent materials have loss factors that rise with increase in frequency and a shear modulus that is relatively flat with frequency. On the other hand, the protein-based polymers have large loss factors at low frequencies, have loss factor that decrease with frequency, and have shear modulus that sharply increase at the high frequency end. These results demonstrate that these new materials hold great promise in their application as materials for broad band anechoic coatings for ships and submarines.

14. SUBJECT TERMS

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FINAL REPORT

GRANT # : N00014-99-WX-20344

PRINCIPAL INVESTIGATOR: Dr. Jack Y. Dea

INSTITUTION: SPAWAR SYSTEMS CENTER

GRANT TITLE: Material and Acoustical Studies of Elastic Protein-Based
Polymers Engineered for Selected Acoustical and Non-Acoustical
Characteristics

OBJECTIVE: Measure and evaluate the elastic and acoustical properties
of elastic protein-based polymers engineered for selected acoustical
and non-acoustical characteristics.

APPROACH: Elastic protein-based polymers are produced by Bioelastics,
Inc. These polymers are engineered to have low frequency acoustical
absorption. These polymers are send to SPAWAR SYSTEMS CENTER for
analysis on elastic properties.

ACCOMPLISHMENTS: Elastic protein-based polymers have been synthesized
by Professor Urry and his group to provide selected acoustical
absorption. These polymers are solid materials, having been cross-
linked by gamma-ray irradiation. Three (3) of these polymers (names I,
II and III) have been measured in Dr. Lev Sheiba's experimental set-up.
Dr. Sheiba's system can measure all the elastic parameters of a small
piece of material without the necessity of large samples and without
the incursion of large errors. The measurement results showed that all
3 polymers, especially polymers II and III, have excellent acoustical
absorption characteristics as shown in their loss factor plots. Their
characteristics are different from those of traditional rubbers and
polyurethanes in the designated frequency range of 200 Hz to 7 kHz.
These results demonstrate that these new materials hold great promise
in their application as materials for broad band anechoic coatings for
submarine stealth technology.

CONCLUSIONS: The shear modulus, bulk modulus and loss factor at various
temperatures have been experimentally determined for 3 protein-based
materials, Polymer I, Polymer II, and Polymer III. These samples were
synthesized in Professor Urry's laboratory. The shear modulus and loss
factors for Polymers I, II and III are significantly different from
traditional elastic materials such as polyurethane (PAN10), and natural
rubber. Typical absorbent materials, natural rubber and PAN10
(polyurethane), have loss factors that rise with frequency, loss
factors of around 0.2 to 0.3 and relatively flat shear modulus with
frequency. On the other hand, the loss factor of the protein-based
elastic polymers have large loss factors at low frequencies (around
1.0), loss factors that decrease at with frequency at the high
frequency end, and shear modulus that sharply increase at the high
frequency end.

SIGNIFICANCE: According to Dr. Sheiba, these characteristics of the
elastic protein-based polymers are EXACTLY the qualities needed for
stealth coatings for submarines. The high loss factor at low
frequencies is quite clearly the characteristics needed for low
frequency sonar absorption. The behavior of the loss factor and the

shear modulus at the higher frequencies insure good broadband sonar absorption. In fact, Dr. Sheiba has always claimed that a loss factor that decreases with frequency would be the ideal characteristic for broad band absorption. However, typical elastic materials, such as polyurethane and natural rubber, do not show these characteristics. Our elastic protein-based polymers are really quite unique with respect to these desired characteristics.

PUBLICATION AND ABSTRACTS:

1. Urry, D.W., Hugel, T., Seitz, M. Gaub, H., Sheiba, L., Dea, J., Xu, J., Parker, T. (2001) Elastin: A representative ideal protein elastomer. Abstract presented to Royal Society Meeting, London, May 16-17.